Running long and complex processes with PostGIS

Vincent Picavet

FOSS4G 2010 - Barcelona

Oslandia, who's that ?

Oslandia

Young French SME specialised in Open Source GIS

PostGIS experts: Vincent Picavet & Olivier Courtin

- Mainly Focuses on:
  - **Spatial Databases** (PostGIS, SpatiaLite)
  - OGC, ISO, INSPIRE **Standards** and **SDI architecture**
  - **Complex analysis** : Routing, Network and Graphs Solutions

Oslandia's ecosystem:

Oslandia's Technologies

3D GDAL GEOS

GRASS GraphServer INSPIRE MapServer

OGC PgRouting **PostGIS**

PostgreSQL Spatialite TinyOWS

TileCache PyWPS QGIS

Oslandia, Find us at FOSS4G

Running long and complexes processes with PostGIS

Vincent Picavet, Wednesday - 12h00 – Sala 6

PostGIS meets the third dimension

Olivier Courtin, Wednesday - 12h30 – Sala 6

State of the Art of FOSS4G for Topology and Network Analysis

Vincent Picavet, Thursday – 14h30 – Sala 5

FOSS4G 2010 Barcelona

Oslandia : Bronze Sponsor

Breakout Session: Spatial Databases

Code Sprint on Friday: PostGIS

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What you'll see and do next

- Step 1 : **Use case** presentation
- Step 2 : Special use **characteristics**
- Step 3 : **Issues** and **solutions**
- Step 4 : **Conclusion**
- Step 5 : **Perspectives**

- Step 6 : Stay here for Olivier's presentation
- Step 7 : Run for lunch

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Step 1 : Use case

Use case

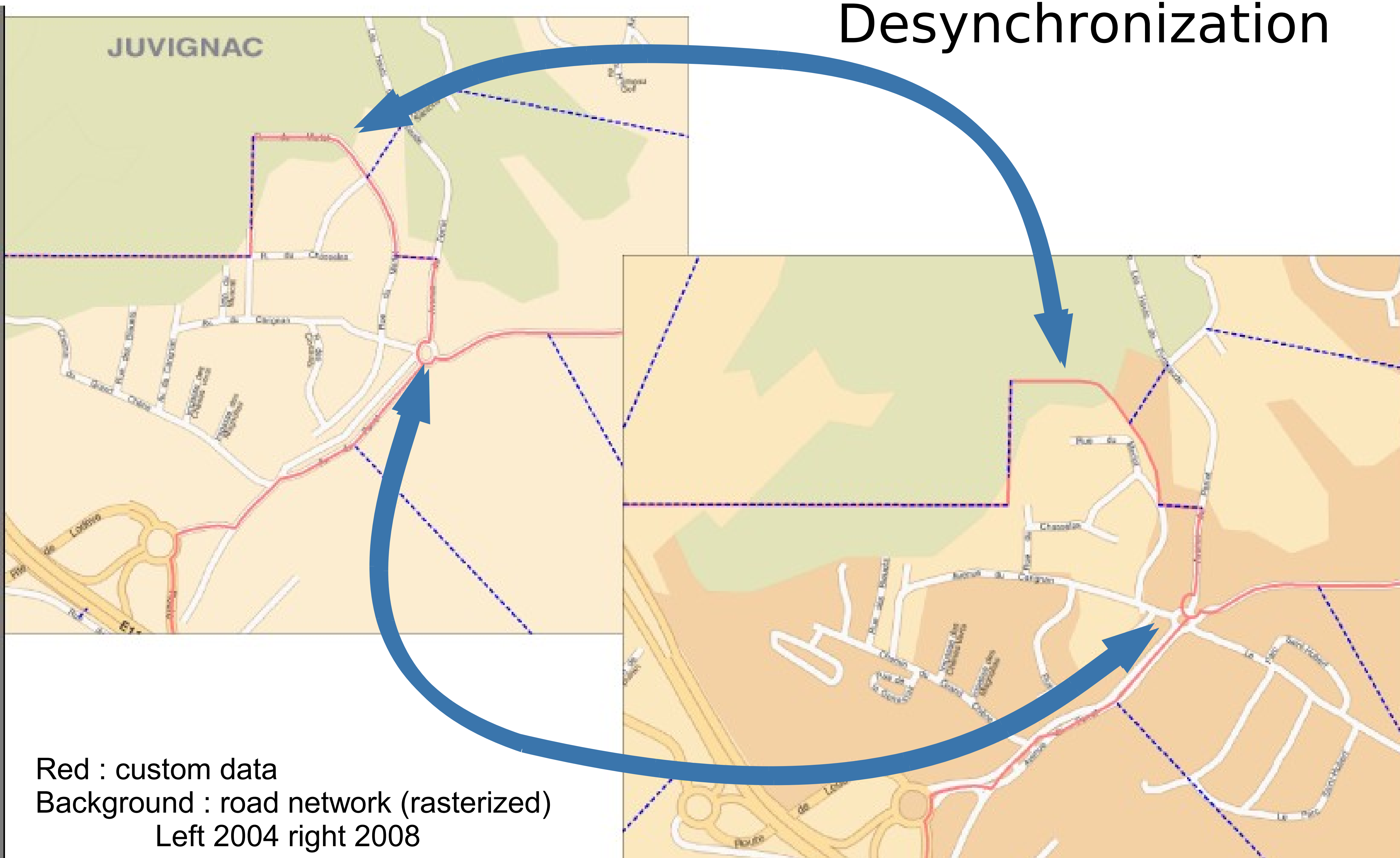
- Road network data (TA)
- + Custom client data linked to the network
- Initial network data imported in 2004
- Parallel evolution during 4 years
  - Client modified road network data
  - TA modified road network data
- No ID stability on TA data

→ **data de-synchronization**

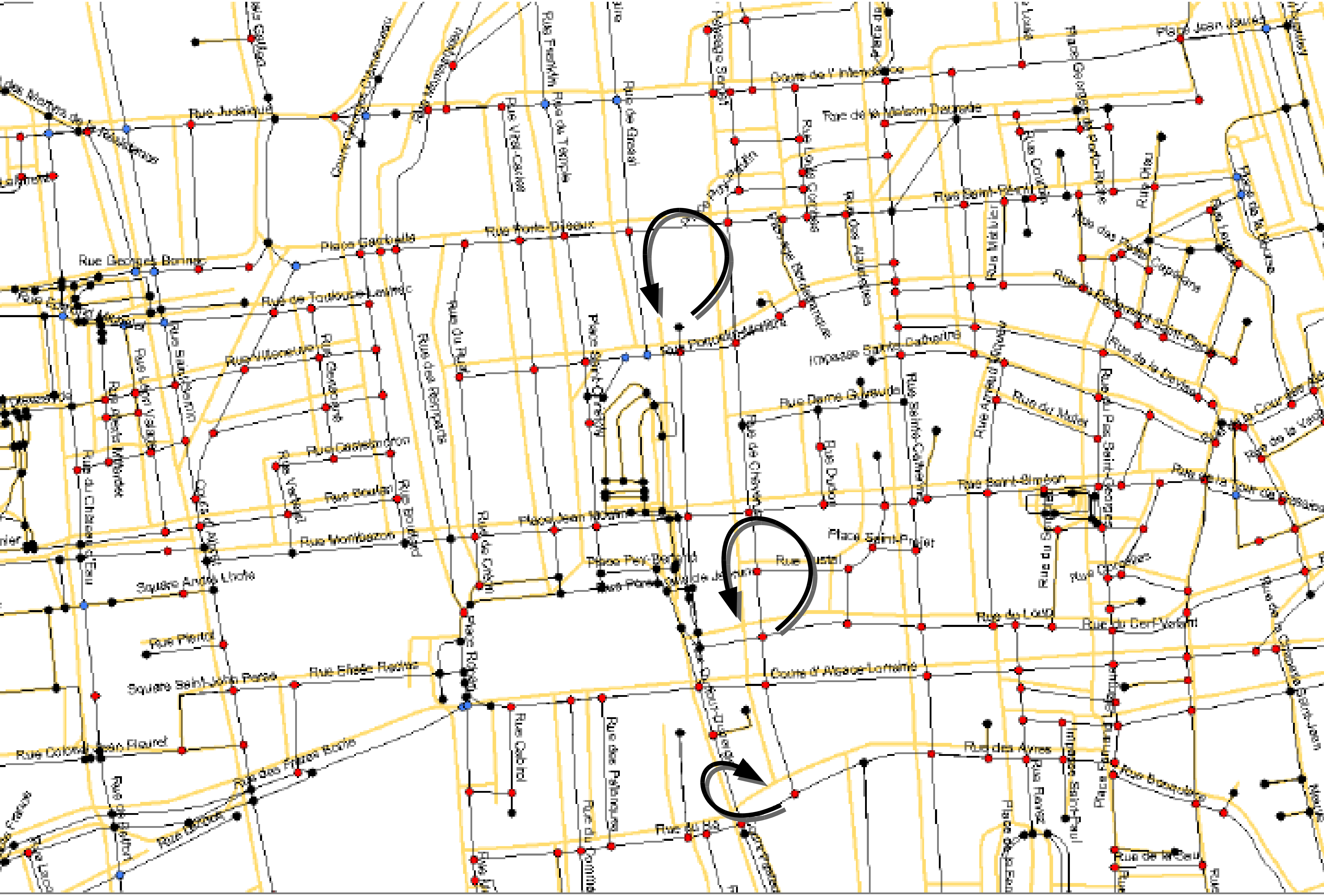
Same-same, but different

Use case

Desynchronization



Red : custom data
Background : road network (rasterized)
Left 2004 right 2008



Rue Judaïque
Cours de l'Intendance
Place Jean Jaurès
Rue Franklin
Rue du Temple
Rue Vital-Carles
Rue de Grassi
Rue Porte-Dijeaux
Place Gambetta
Rue Georges Bonnac
Rue de Toulouse-Lautrec
Rue Saint-Rémi
Impasse Sainte-Catherine
Rue Sainte-Catherine
Rue des Remparts
Rue Castelnau d'Auros
Rue Saint-Siméon
Place Saint-Projet
Place Jean Moulin
Rue Montbazon
Square André Lhote
Rue du Loup
Rue du Cerf Volant
Cours d'Alsace-Lorraine
Square Saint-John Perse
Rue Elisée Reclus
Rue des Frères Bonie
Rue des Ayres
Rue du Château d'Eau
Rue de Cursol
Rue de Cheverus
Rue Ravez

Goal

- **Re-synch** custom data with up-to-date network
  - **Graph pairing**

    = match networks streets, nodes, road sections
  - Re-link or rebuild custom data on new network
  - Have a full road network data update process
- **Automate** this process
  - Enable fully automated and regular data update

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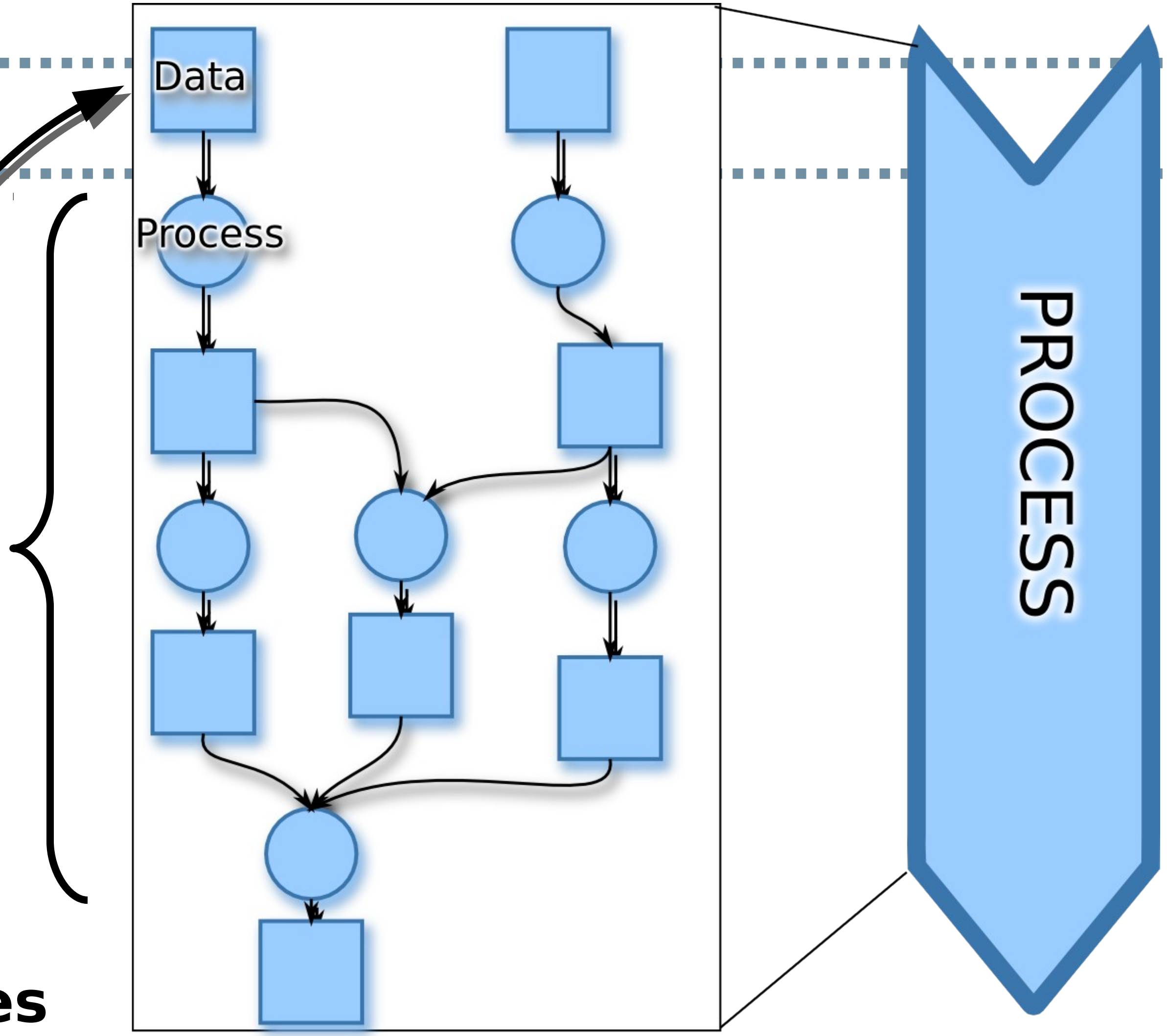
Process



Our process

- Load data
- **Graph pairing modules (nodes, streets, sections)**
  - **Semantic,**
  - **topological**
  - **and geometrical subprocesses**
- Export output data

Facts & numbers

- Our **data set**
  - **70%** of french population (~40M)
  - **50 Tables**
  - **10M rows**
  - **150Go** at end of process
  - **30K SQL and plpgsql** lines
  - **3000** queries, **6000** Python lines
- Our dev team
  - **3 Mapinfo** users and **1** PostGIS expert

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Results

- 2004 → 2008 :
  - 70% road sections pairing
  - **93% custom data pairing**

- 2008 → 2009 :
  - 99% road sections pairing
  - **99.95% custom data pairing**

- Less difference between networks
- Custom data have been cleaned

Step 2 : Characteristics

Use case characteristics

- «ELT» : **Extract, Load, Transform**
- PostgreSQL + PostGIS + external tools

- Big volumes
- **Long, heavy and complex** computation process
  - Global production time ~ 20 days
  - Pairing : 5 days
- **Long SQL transactions**

Step 3 :
Issues and solutions

Issues and solutions

#1 – Hardware and server configuration

#2 – Testing

#3 – Monitoring

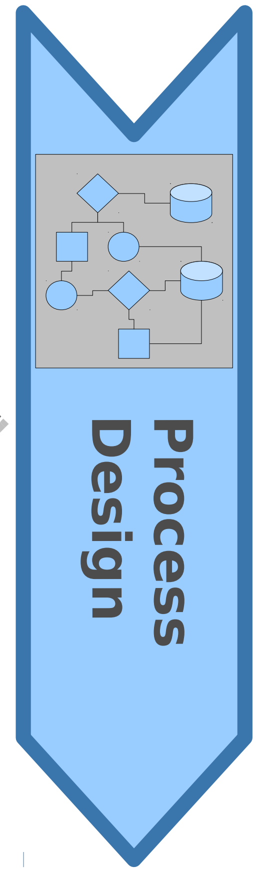
#4 – Dealing with corner cases

#5 – Splitting process

#6 – Stability

#7 – Optimization

#8 – Process improvement



⇨ Almost all of this is linked to the way you **design your process.**

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#1 – Hardware and configuration

- Adapted hardware is essential
  - Buy **RAM**
  - Buy more **RAM**
  - Buy more **RAM**
  - Buy disks
  - Buy faster disks

And use it !

- Server configuration is **hard**
  - System monitoring
  - Depends on the process
  - Dynamic configuration
    - Fine-tune according to query plan
  - Needs experience
  - Needs testing

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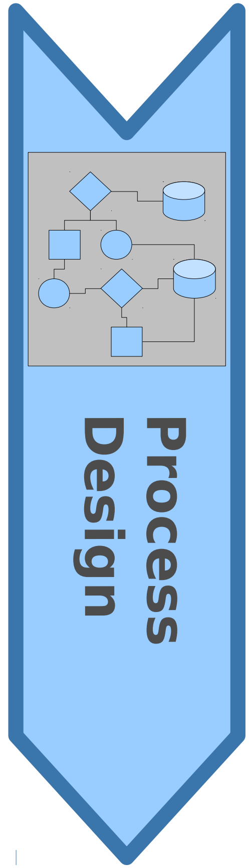
#2 – Testing

- Testing for **correctness**
  - Ok on sample for development
  - Corner case problems on full data
- Testing for **performance**
  - Meaningless on samples
  - Very long on real data
- Solutions
  - Split process
  - «Unit test» modules
  - Guess and oversize everything



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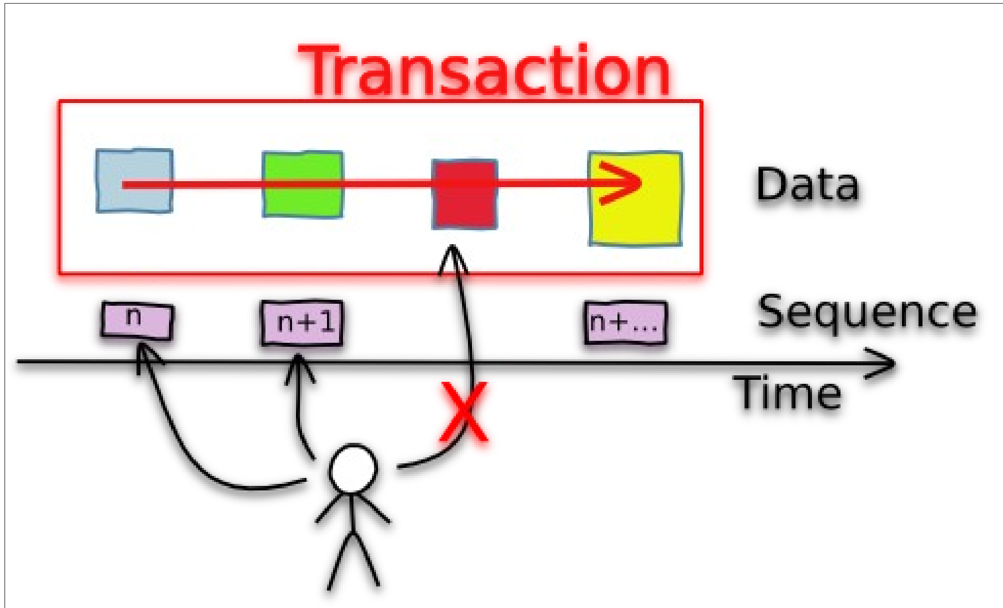
#3 – Monitoring, validating – MVCC

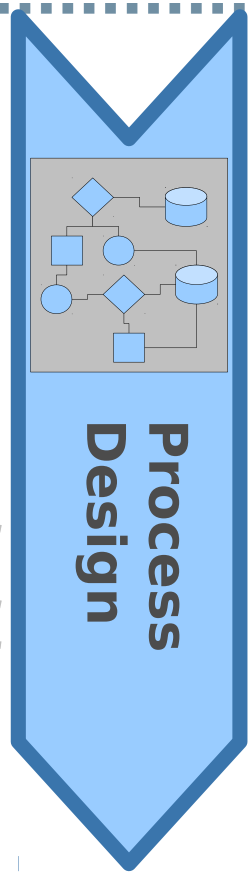
- **MVCC** = Multi-View Concurrency Control
- → concurrent access on data
- → Transactions isolated until committed
- → No easy way to access a running transaction

- Use smaller transactions
- Sequence monitoring : sequences live out of MVCC
  - *nextval('myseq')* in query
  - *currval('myseq')* gets progression



#3 – Monitoring and validating

- **System** monitoring
  - Memory, disk access
  - Shows process stability and steps
- **Post-process** monitoring and validation
  - Log analysis
  - Validation processes on result tables
  - Statistics on result tables
- Intra-process monitoring and validation
  - ⇨ Split process



#4 – Corner cases - issue

- Computations with geometry is

not an exact science

<= **Data error & imprecision**
<= **Floating point models limits**
<= **Robustness of algorithms**
<= **Error propagation**

#4 – Corner cases - issue

99.999999% success
1M rows

1 Geometry computation error

transaction fails !

- Every additional «9» costs a lot more than precedent
  - Performance-wise, code complexity-wise
- Success rate drops with computation complexity

  <= Error propagation

→ **Impossible to predict** all corner cases

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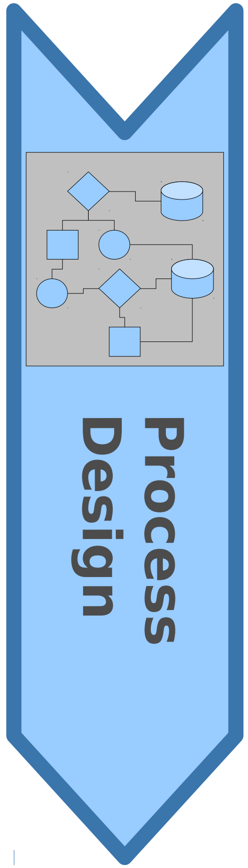
#4 – Corner cases – Actual Solutions

- **Split** process in chunks
- Preprocess and simplify data
  - Snap to grid (= reduce input precision)
  - Simplify
- Catch errors to ignore them
  - Using exception catching in plpgsql
  - ⇨ Not precise enough (catch all)
  - ⇨ Less stability



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#4 – Corner cases – Potential solutions

- Finely handle **errors**
  - Specific exceptions
  - Discuss use cases to decide returning NULL or error

- Change floating point models
  - Enable **custom FP models** (In JTS and GEOS, not PostGIS)
  - Dynamic floating point precision model
  - Exact computation (costs a lot)

- More robust algorithms

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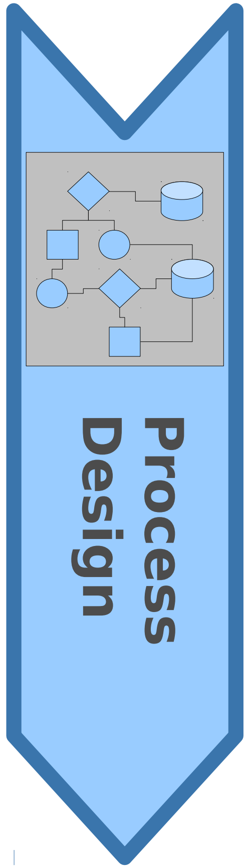
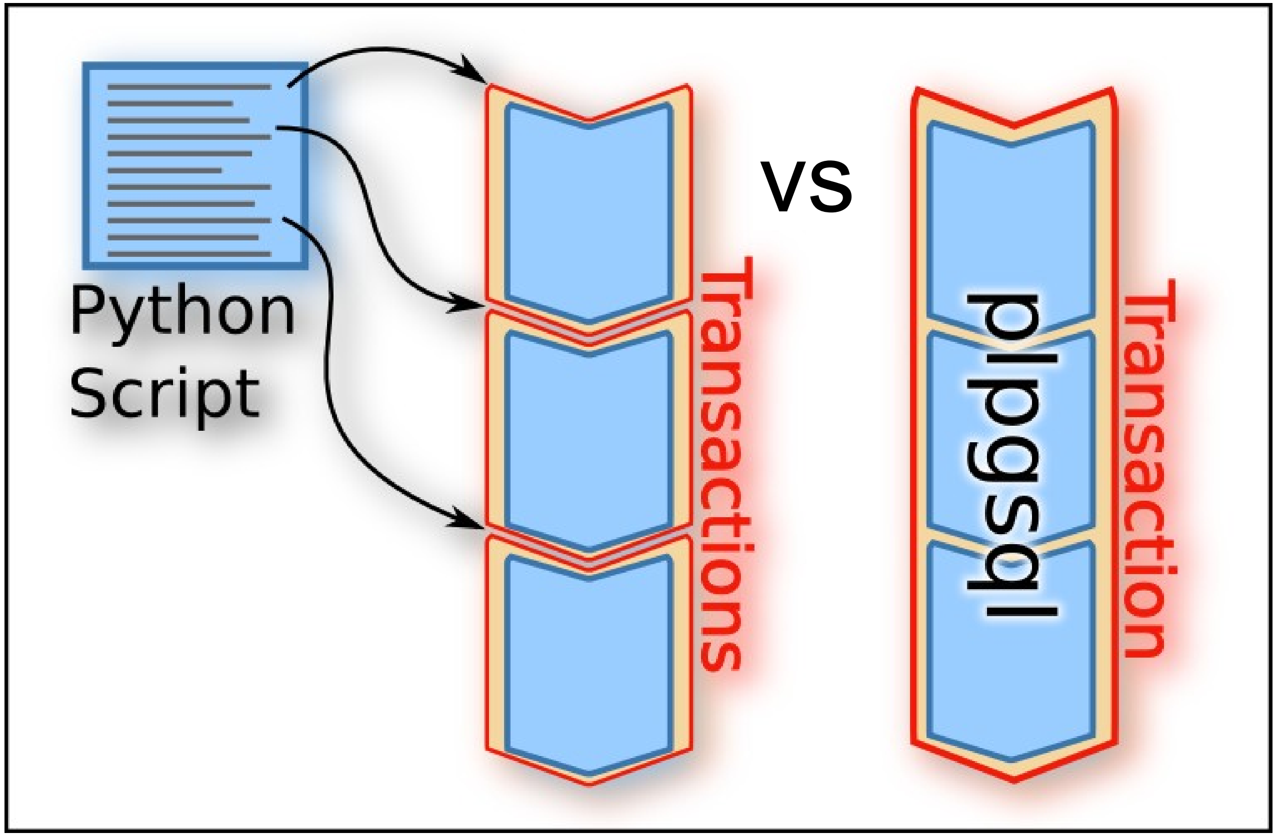
#5 – Split your process

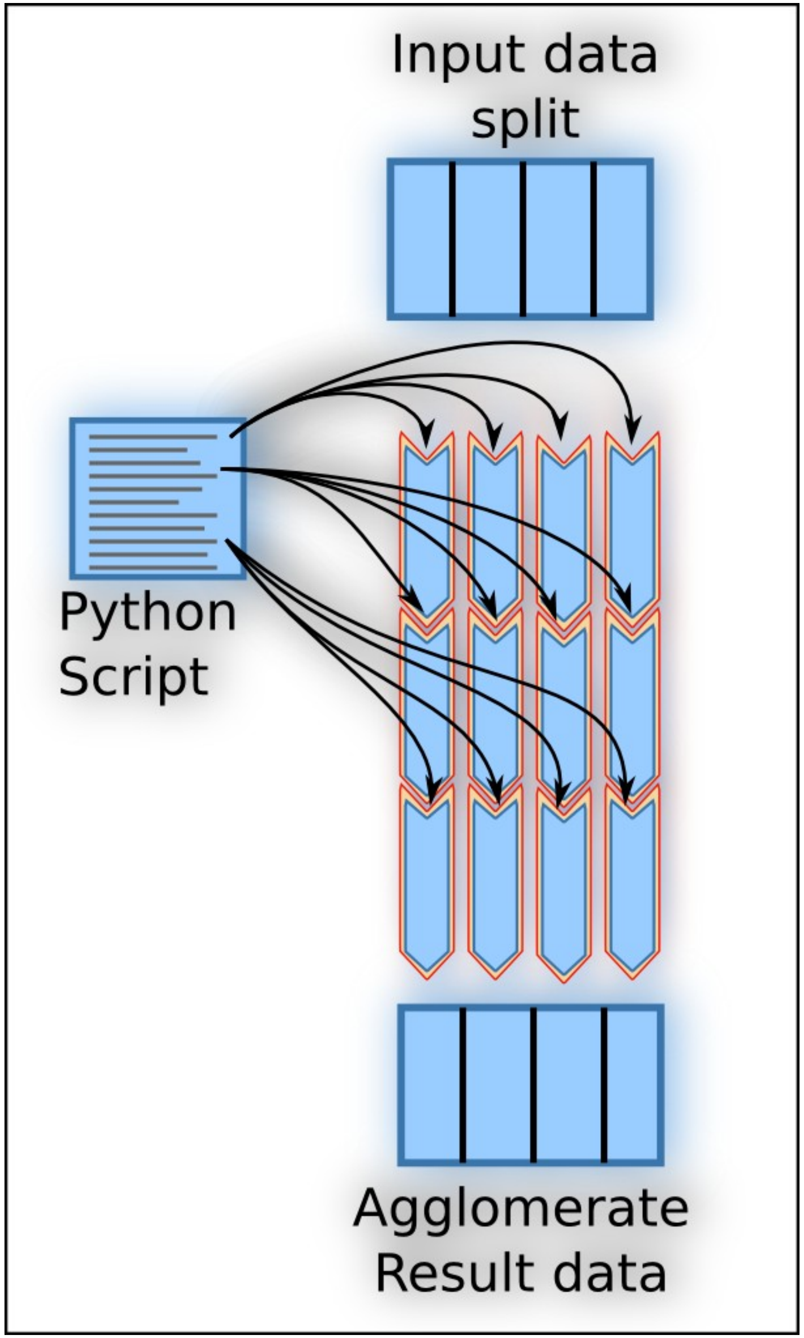
- Split computations
- Split data
- Not possible in plpgsql
  - <= no nested transaction
- Needs a process driver
  - Python is our driver
- Enables
  - Intra-process operations
    Backup, validate, stats, monitor...)
  - partial computation & diff updates
  - // computation



Python driver =>

#5 – Split your process





#6 – Stability

- Memory management in PG is smart
  - Memory allocated and freed per transaction context
  - PostGIS uses it, not GEOS
- Longer transactions
- Some GEOS memory leaks
- Catching geometric errors

increase instability

- Use recent PostgreSQL release
- Do. Not. Use. Windows. Servers. Ever. (we did)

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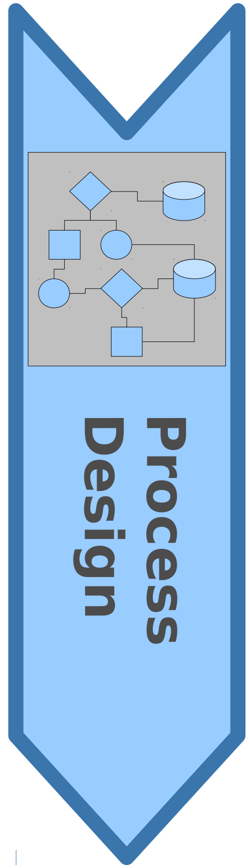
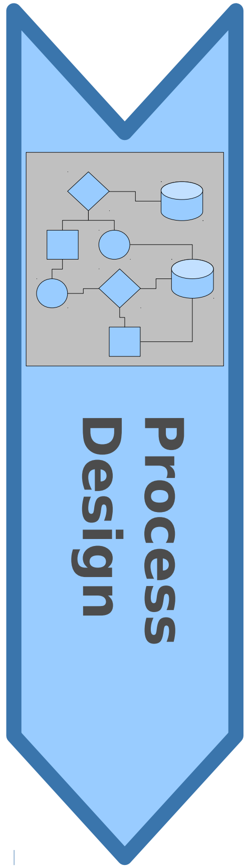
#7 – Optimizing

- Indexes
  - Necessary for geometric operations
  - Must be finely tuned
  - Drop, modify, recreate (automated in plpgsql)
- Constraints
  - Same : drop, modify, recreate
  - Or replace by validation steps
- Maintenance
  - Vacuum vs autovacuum
- Quit plpgsql
  - PostgreSQL C modules are fun ! – and efficient



#8 – Process improvement

- Less geometry computation
- More topology and attribute-based processes
- Base computation on input data
  - Less computation errors
  - Less error propagation
  - Use original cleaned data
- Use PostGIS mainly :
  - in data preparation
  - geometry rebuilding at the end



Step 4 : Conclusion

So what ?

- It works !
- Good results at the end

- Ease of use for PostgreSQL/PostGIS newbie developers
  - With expert assistance on problematic points

- **Designing the process workflow carefully and thoroughly is the key**

Step 5 : Perspectives

What more then ?

- PostgreSQL improvement
  - HOT standby => parallel work
  - Nested transaction support ?
  - Better autovacuum
- In our case
  - Horizontal process split effort
  - Parallel processing
  - Differential work
- NoSQL «DB» ?
  - Map/Reduce system

That's all folks !

Want to know more ?

Ask now or write to :

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